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Structural Adhesives

Developing adhesives and bonded joints for demanding applications

Polymeric adhesives are used in a variety of joining applications at LLNL. Many of these applications place high demands on the adhesive—such as bonding to dissimilar materials, long life with consistent performance, and chemical compatibility in the presence of potentially reactive and corrosive materials. Our experience and success show that LLNL is uniquely suited for developing adhesives and bonded joints for demanding applications. We also have the facilities and expertise to fully characterize the properties, performance, and behavior of adhesives and bonded joints, both experimentally and analytically using three-dimensional finite element analysis.

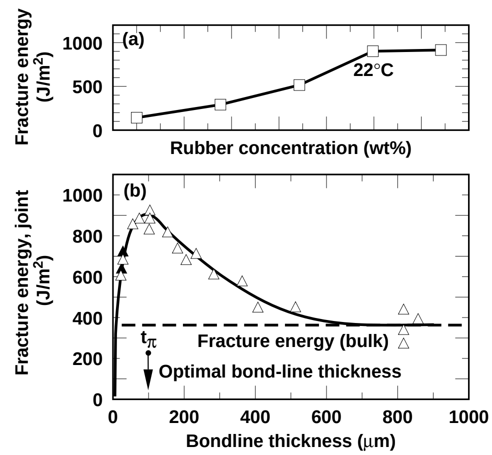
We employ a tightly coupled materials science, computer modeling, and analytical mechanics approach to joint design using concurrent engineering principles.

Recent accomplishments

- A high-strength optical adhesive that can withstand a 1-GW laser fluence, for bonding phosphate glass amplifiers in Nova, the world's largest laser. LLNL was recognized for this adhesive with an R&D 100 award in 1988.
- A moderate-temperature-curing structural adhesive for bonding beryllium oxide, a brittle ceramic. Made from commercially available precursors, this new rubber-toughened adhesive exhibits a joint fracture energy of about 1 kJ/m^2, a glass transition temperature of about 90°C, and a low liquid surface tension of 32 dyn/cm^2 that ensures effective wetting and bonding to beryllium oxide.
- Evaluation of cylindrical shear joints for composite tubes (*J. Composite Materials*, Vol. 26, No. 8, 1992).

APPLICATIONS

- *Adhesives for demanding applications requiring long-life, consistent performance, and chemical compatibility*
- *Adhesives for joining difficult materials like glasses, ceramics, and reactive, corrosive materials*



Fracture energy of a toughened epoxy adhesive as a function of (a) rubber concentration and (b) bond-line thickness, showing optimal additive concentration and joint geometry.

In-house capabilities

Our in-house testing and characterization capabilities are extensive and include

- Mechanical properties (static, dynamic, and high rate)
- Fracture and crack propagation behavior in bulk polymer and bonded joints
- Chemical cure kinetics and rheology
- Physical and thermal properties (e.g., calorimetry, dialtometry)
- Long-term stability and compatibility.

We also perform three-dimensional finite-element modeling of bonded joints using realistic viscoplastic constitutive models of adhesive response.

Availability: Structural adhesives are available now. We are looking for industrial collaborators with whom we can develop adhesives and bonded joints for many applications.

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